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The immersion freezing behavior of mixtures of mineral dust and biological substances

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Biological particles such as bacteria or pollen are known to be efficient ice nuclei. It is also known that ice nucleating active (INA) macromolecules, i.e. protein complexes in the case of bacteria (e.g. Wolber et al., 1986), and most likely polysaccharides in the case of pollen (Pummer et al., 2012) are responsible for the freezing. Very recently it was suggested that these INA macromolecules maintain their nucleating ability even when they are separated from their original carriers (Hartmann et al., 2013; Augustin et al., 2013). This opens the possibility of accumulation of such INA macromolecules in e.g. soils and the resulting particles could be an internal mixture of mineral dust and INA macromolecules. If such biological IN containing soil particles are then dispersed into the atmosphere due to e.g. wind erosion or agricultural processes they could induce ice nucleation at temperatures higher than -20°C.
To explore this hypothesis, we performed a measurement campaign within the research unit INUIT, where we investigated the ice nucleation behavior of mineral dust particles internally mixed with INA macromolecules. Specifically, we mixed pure mineral dust (illite) with INA biological material (SNOMAX and birch pollen washing water) and quantified the immersion freezing behavior of the resulting particles utilizing the Leipzig Aerosol Cloud Interaction Simulator (LACIS). To characterize the mixing state of the produced aerosol we used single mass spectrometry as well as electron microscopy. We found that internally mixed particles which containing ice active biological material show the same ice nucleation behavior as the purely biological particles. That shows that INA macromolecules which are located on a mineral dust particle dominate the freezing process.
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